NOISE REDUCTION

BACKGROUND

[0001] 1. Technical Field

[0002] The exemplary and non-limiting embodiments relate generally to noise removal and, more particularly, to removing noise generated from an internal non-audio component in an apparatus from a signal.

[0003] 2. Brief Description of Prior Developments

[0004] Non-audio components in mobile devices increasingly have features that cause noise. For example, a mobile device may have a camera which produces noise if features such as AutoFocus (AF) and Optical Image Stabilization (OIS) are used. Because mobile devices are small in size, the noise is easily picked up by the air microphone(s) of the mobile device. This may cause problems to video sound tracks for example.

[0005] Removing camera noise from audio tracks is a significant problem. Camera companies go as far as introducing new lens generations (e.g. CANON with STM lenses) for more silent operation, but with AF motors which are not as good as previous AF motors.

[0006] Removing camera noise from audio tracks can, to some extent, be done by measuring the noise signal caused by the camera to the air microphones and then subtracting the measured signal from the microphone signal when the camera is operational. Within the scope of mobile devices, current noise removal systems typically have a single constant model of the noise, and they apply noise removal when the system "guesses" camera noise to be present. However, variability of the noise over time, component wear, different calibration between microphones, devices and camera components, and changes in the noise when the device is held differently cause the noise to be difficult to estimate without real-time measurements. Thus, a static single constant model for noise reduction of noise generated from an internal non-audio component can be improved upon.

SUMMARY

[0007] The following summary is merely intended to be exemplary. The summary is not intended to limit the scope of the claims.

[0008] In accordance with one aspect, an example apparatus comprises at least one processor; and at least one non-transitory memory including computer program code, the at least one memory and the computer program code configured to, with the at least one processor, cause the apparatus to generate a signal from at least one sound transducer of an apparatus, where the signal is generated based upon sound received at the at least one sound transducer, where the sound includes acoustic noise generated by a component of the apparatus; and remove a noise component from the signal, where the noise component at least partially corresponds to the acoustic noise generated by the component.

[0009] In accordance with another aspect, an example method comprises generating a signal from at least one sound transducer of an apparatus, where the signal is generated based upon sound received at the at least one sound transducer, where the sound includes acoustic noise generated by a component of the apparatus; and remove a noise component from the signal, where the noise component at least partially corresponds to the acoustic noise generated by the component.

[0010] In accordance with another aspect, a non-transitory program storage device readable by a machine is provided, tangibly embodying a program of instructions executable by the machine for performing operations, the operations comprising generate a signal from at least one sound transducer of an apparatus, where the signal is generated based upon sound received at the at least one sound transducer, where the sound includes acoustic noise generated by a component of the apparatus; and remove a noise component from the signal, where the noise component at least partially corresponds to the acoustic noise generated by the component.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The foregoing aspects and other features are explained in the following description, taken in connection with the accompanying drawings, wherein:

[0012] FIG. **1** is a front view of an example embodiment of an apparatus comprising features as described herein;

[0013] FIG. **2** is a rear view of the apparatus shown in FIG. **1**;

[0014] FIG. **3** is a diagram illustrating some of the components of the apparatus shown in FIGS. **1-2**;

[0015] FIG. **4** is a diagram illustrating sound received at the air microphone of the apparatus shown in FIG. **1** corresponding to sound generated by an operation of the camera of the apparatus shown in FIG. **1**;

[0016] FIG. **5** is a diagram illustrating contact vibrations received at the contact microphone of the apparatus shown in FIG. **1** corresponding to vibrations generated by the operation of the camera of the apparatus shown in FIG. **1** as in FIG. **4**;

[0017] FIGS. **6-8** are diagrams illustrating example uses of contact microphone for removing noise from the air microphone signal;

[0018] FIGS. **9-11** are diagrams similar to FIGS. **6-8** illustrating example uses of camera drive signals for removing noise from the air microphone signal;

[0019] FIGS. **12** and **13** are diagram illustration examples of locations of components of the apparatus of FIG. **1** relative to one another;

[0020] FIG. **14** is a diagram illustrating an example method; and

[0021] FIG. **15** is a diagram illustrating an example method.

DETAILED DESCRIPTION OF EMBODIMENTS

[0022] Referring to FIG. **1**, there is shown a front view of an apparatus **10** incorporating features of an example embodiment. Although the features will be described with reference to the example embodiments shown in the drawings, it should be understood that features can be embodied in many alternate forms of embodiments. In addition, any suitable size, shape or type of elements or materials could be used.

[0023] The apparatus **10** may be a hand-held portable apparatus, such as a communications device which includes a telephone application for example. In the example shown the apparatus **10** is a smartphone which includes a camera and a camera application. The apparatus **10** may additionally or alternatively comprise an Internet browser application, a video recorder application, a music player and recorder application, an email application, a navigation application, a gaming application, and/or any other suitable electronic device application. In an alternate example embodiment the appara-